Measurements of Cosmological Parameters Using Long Duationg Gamma-ray Bursts

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Recent Researches on long duration gamma-ray bursts (GRBs) show that GRBs have two possible luminosity indicators, the spectral lag time and the variability, which can be used to independently derive the luminosity distance of GRBs. Schaefer (2003) used these relations to construct the GRB Hubble diagram from nine qualified GRBs [1]. Here we present a method to constrain some Cosmological parameters (Ω_m, Ω_Λ, and H_0) using results in Schaefer (2003). The first results show that $\Omega_m = 0.2 \pm 0.2$, $\Omega_\Lambda = 0.4 \pm 0.6$ with a prior $H_0 = 68 km s^{-1} Mpc^{-1}$, and that $\Omega_m = 0.25 \pm 0.1$ for a flat universe and $H_0 = 68 km s^{-1} Mpc^{-1}$, and that $H_0 = 68 \pm 6 km s^{-1} Mpc^{-1}$ for a flat universe with $\Omega_m = 0.3$.

I. INTRODUCTION

Since the first optical and radio counterparts of gamma-ray bursts were discovered in 1997, there is no doubt that at least the long-duration GRBs are originated at cosmological distances [2–4]. Recently, two research groups have proposed that long-duration GRBs probably ahve two luminosity or distance indicators [5,6]. One proposed that the luminosity of GRBs is related with the spectra lag, the time delays between high and low energy X-ray photons [5]; The other one proposed that the burst luminosity is related with the variability, the number of spikes of the GRB light curve [6]. Using these two distance indicators, Schaefer built up the GRB Hubble diagram, *i.e.*, the luminosity distance as a function of redshift, from nine well-observed GRBs [1]. This result provided another way, independent of supernovae, cosmic microwave background (CMB), and large scale structures (LLSs), to constrain the cosmological constant, dark matter parameter and acceleration of the universe.

In this poster, we will present the first results of measurements of matter density parameter Ω_m, cosmological constant parameter Ω_Λ, and H_0 using results in Schaefer (2003) [1].
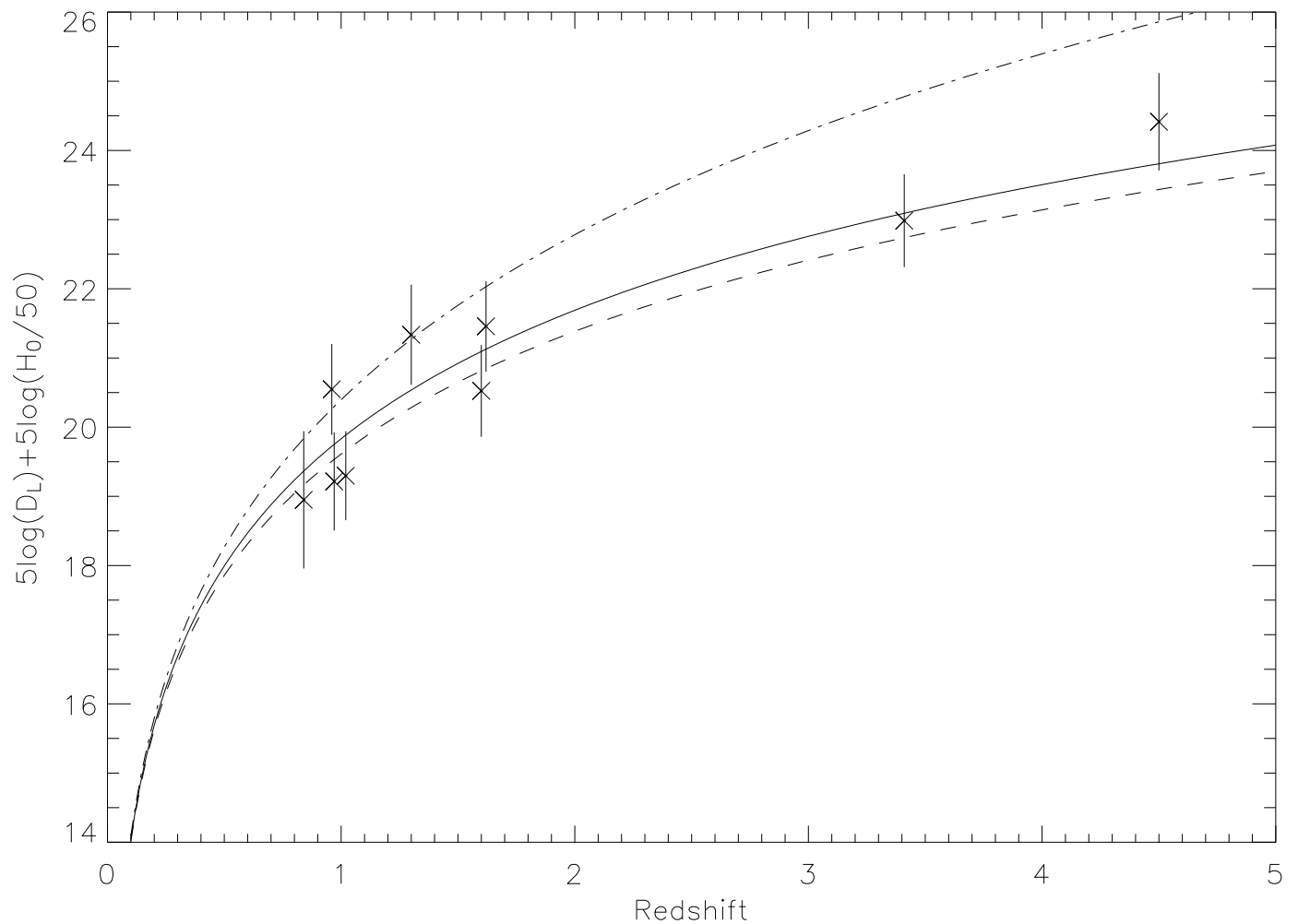
II. THE FIRST RESULTS

FIG. 1. The luminosity distance d_L as a function of redshift z. The data points are recalculated

from Schaefer (2003). All three theoretical curves are for a flat universe. The solid curve is the d_L-z

relation with $\Omega_m = 0.3$, the dashed curve is for $\Omega_m = 0.5$, and the dash-dot curve is for $\Omega_m = 0$.
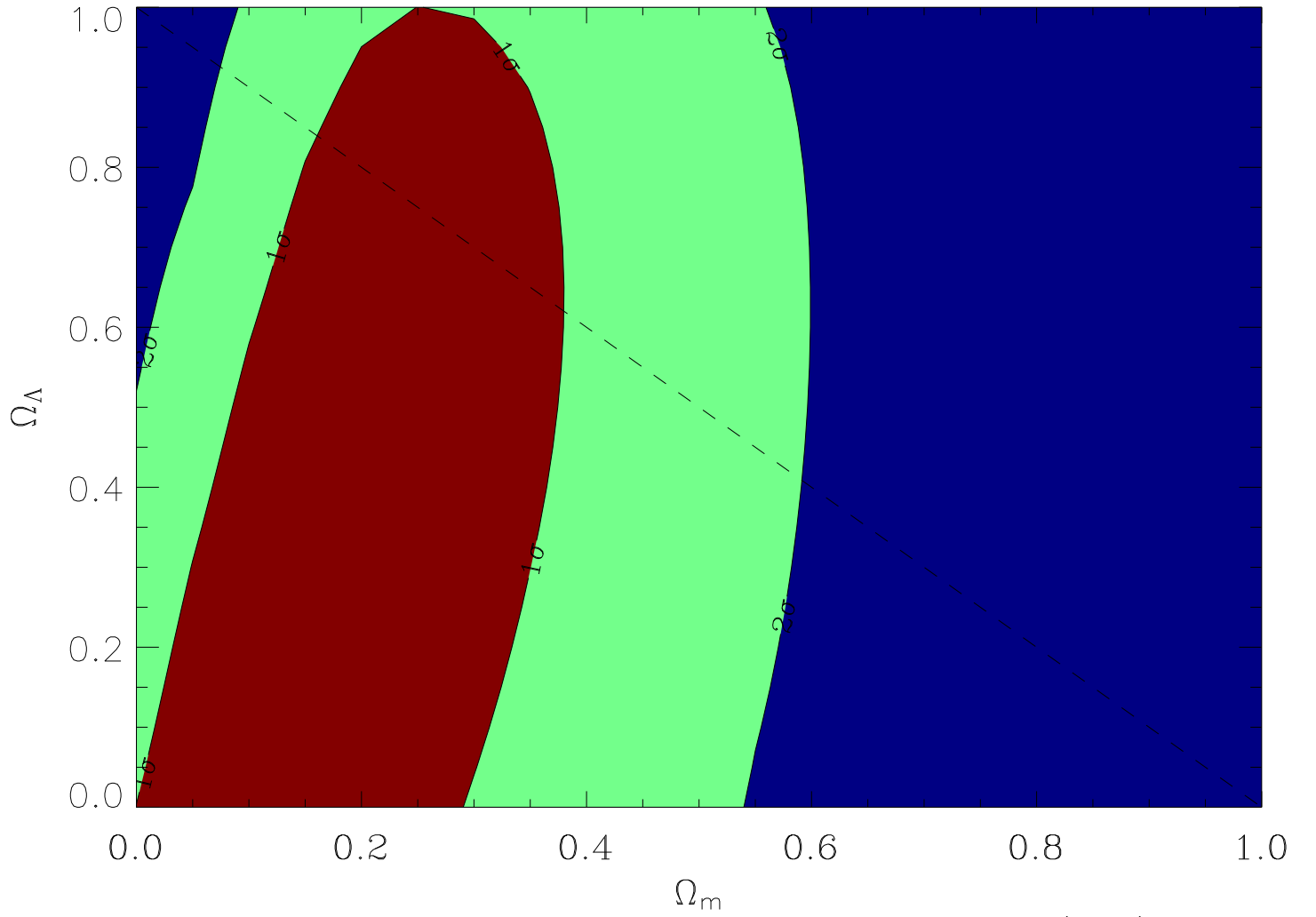
FIG. 2. The contour plot of constraint on Ω_m and Ω_Λ with a prior of $H_0 = 68 km s^{-1} Mpc^{-1}$.

Our measurements of Ω_m and Ω_Λ are $\Omega_m = 0.2 \pm 0.2$, $\Omega_\Lambda = 0.4 \pm 0.6$ respectively. The dashed line is for a flat universe.

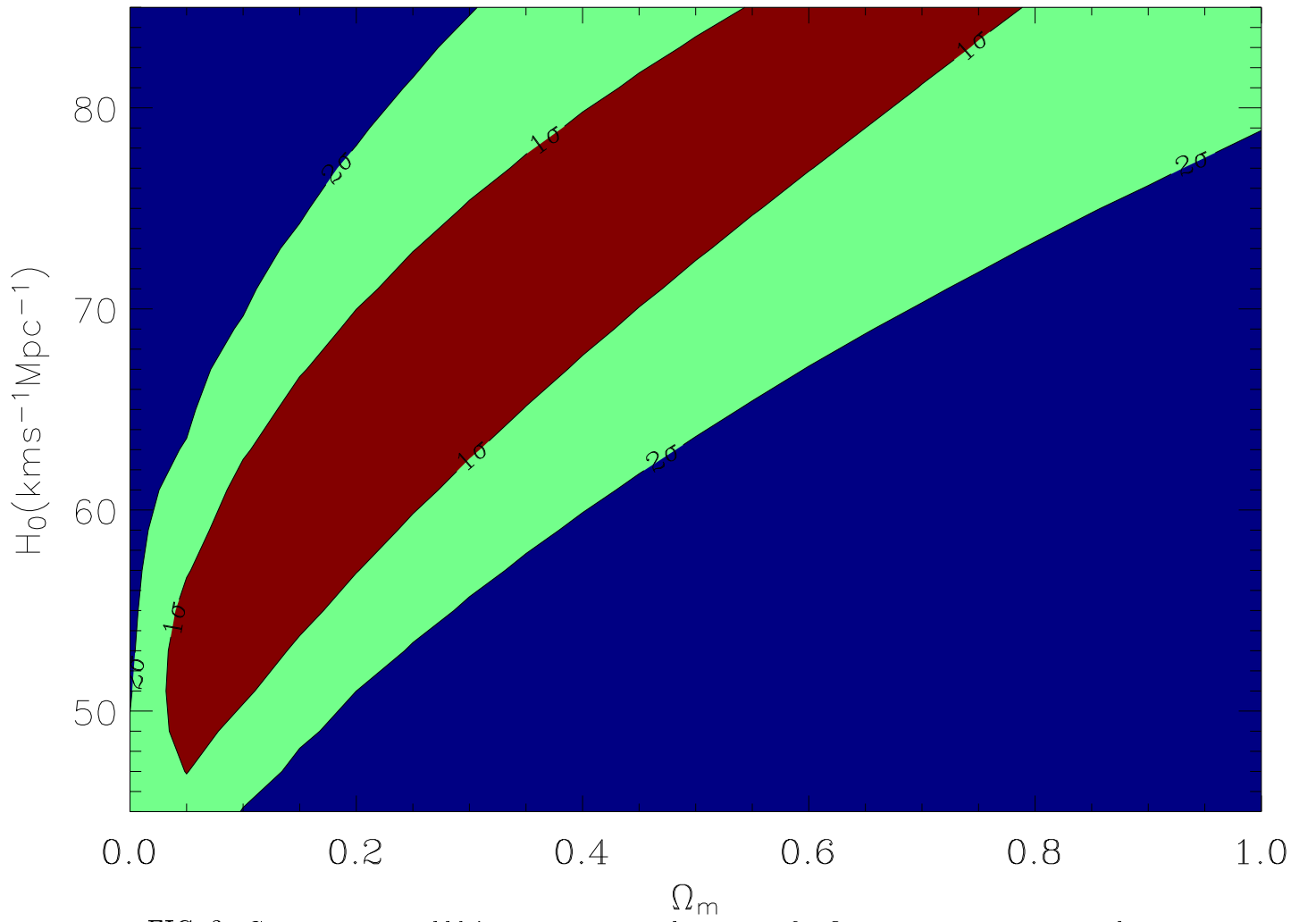FIG. 3. Constraint on Hubble's constant H_0 with a prior of a flat universe. We can see that

$H_0 = 68 \pm 6 km s^{-1} Mpc^{-1}$ if $\Omega_m = 0.3$.

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[3] van Paradijs, J. *et al.*, 1997, *Nature*, 386, 686

[4] Frail, D. *et al.*, 1997, *Nature*, 389, 261

[5] Norris, J. P., Marani, G. F., & Bonnell, J. T. 2000, *ApJ*, 534, 248

[6] Fenimore, E. E., & Ramirez-Ruiz, E. 2000, *ApJ*, submitted (astro-ph/0004176)